ADVANCED TECHNIQUES IN SIGNAL PROCESSING

MODULE-I

Introduction to DSP System: Representation of DSP algorithms.
Iteration Bound: Data-flow graph representations, Loop bound and iterartion bound, Algorithms for computing iteration bound, Iteration bound of multirate data-flow graphs.
Pipelining and Parallel Processing: Pipelining of FIR digital filters, Parallel processing, Pipelining and parallel processing for low power.
Retiming: Definitions and properties, Solving systems of inequalities, Retiming techniques.
Unfolding: An algorithm for unfolding, Properties of unfolding, Critical path, unfolding and retiming, Applications of unfolding.
Folding: Folding transformation, Register minimization techniques, Register minimization in folding architectures, Folding of multirate systems.

MODULE-II

Winer Filtering: Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter.
Spectrum Estimation: Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation. Frequency Estimation- Eigendecomposition of the Autocorrelation Matrix, MUSIC.

MODULE III

Adaptive Filtering: Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS.

MODULE IV

Cardiovascular system: Heart structure, cardiac cycle, **ECG** (electrocardiogram) theory (B.D.), **PCG** (phonocardiogram). **EEG, X-Ray, Sonography, CT-Scan**,The nature of biomedical signals.

Analog signal processing of Biosignals: Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits, Active filters, Rate Measurement. Averaging and Integrator Circuits, Transient Protection circuits.

Time-frequency representations: Introduction, Short-time Fourier transform, spectrogram, wavelet signal decomposition.

Biomedical applications: Fourier, Laplace and z-transforms, autocorrelation, crosscorrelation, power spectral density.

Noise: Different sources of noise, Noise removal and signal compensation.

Text Books:

1. K. K. Parhi, *VLSI Digital Signal Processing Systems*, *Design and Implementation*, Wiley India Pvt. Ltd., New Delhi
2. R S Kandpur, *Handbook of Biomedical Instrumentation*, 2nd Edn, TMH Publication, 2003
3. E. N. Bruce, *Biomedical Signal Processing and Signal Modelling*, John Wiley, 2001.
4. Bernard Widrow and Samuel D. Stearns, *Adaptive Signal Processing*, Pearson Education.
5. Monson H. Hayes, *Statistical Digital Signal Processing & Modeling*, John Wiley & Sons
6. J.G. Proakis, D.G. Manolakis, *Digital Signal Processing*, PHI, New Delhi, 1995.

Recommended Reading:

1. Cromwell, *Biomedical Instrumentation and Measurements*, 2nd Edn, Pearson Education.
2. M. A. kay, *Time Frequency and Wavelets in Biomedical Signal Processing*, IEEE Press,1998.
3. Simon Haykin, *Adaptive Filter Theory*, 4th Edn. Pearson Education.
4. K.P. Keshab, *VLSI Digital Signal Processing Systems: Design and Implementation*, Jacaranda Wiley, 1999.
5. S.J. Orfanidis, Optimum Signal Processing, Mac Millan Publishing Co., USA, 1985.